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**Amemori et al.**

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(54) **BOARD-TO-BOARD ELECTRICAL CONNECTOR SET HAVING PROJECTING PORTIONS AND GUIDING PORTIONS**

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Jul. 24, 2017 (JP) ..... 2017-142562

(51) **Int. Cl.**
***H01R 12/71*** (2011.01)
***H01R 24/60*** (2011.01)
(Continued)

(52) **U.S. Cl.**
CPC ..... ***H01R 24/60*** (2013.01); ***H01R 13/6592*** (2013.01); *H01R 12/52* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC ..... H01R 12/716; H01R 12/73; H01R 12/79; H01R 12/7082; H01R 13/642;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,758,029 B2 * 6/2014 Midorikawa ..... H01R 13/2407 439/74
9,196,984 B2 * 11/2015 Ishida ..... H01R 12/716
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2008-226477 A 9/2008
JP 2015-082446 A 4/2015
(Continued)

OTHER PUBLICATIONS

International Search Report issued in PCT/JP2018/020057; dated Aug. 21, 2018.
(Continued)

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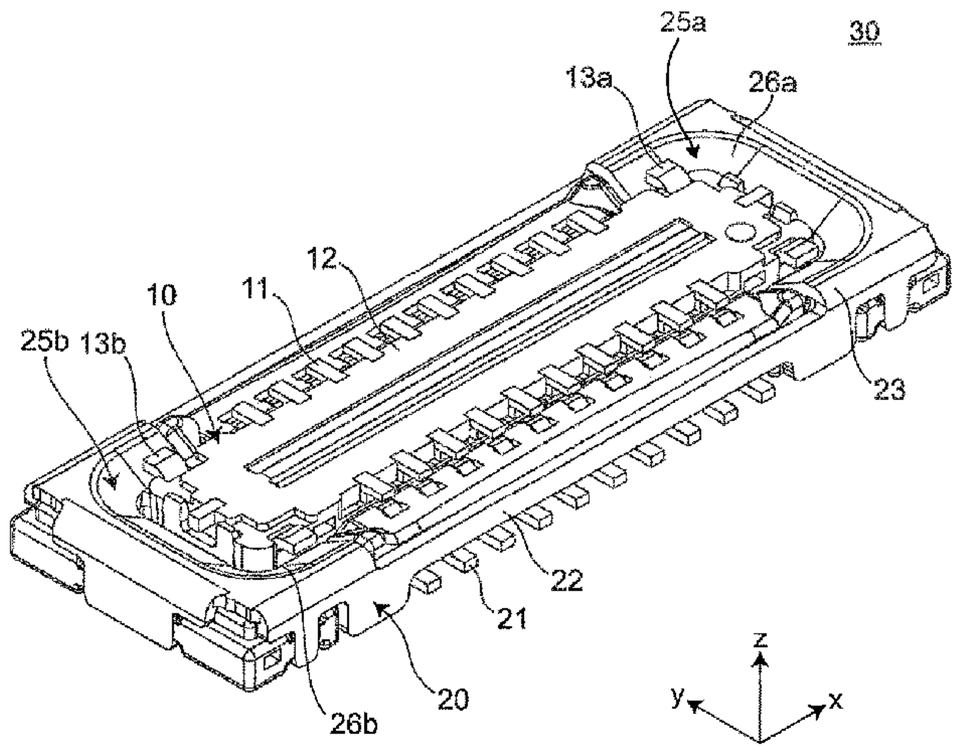
(57) **ABSTRACT**

A connector including a first connector and a second connector configured to face each to fit together. The first connector includes a first internal terminal including terminals along a longitudinal direction, a first insulating member supporting the first internal terminal, and first external terminals at two ends of the first internal terminal in the longitudinal direction. The second connector includes a second internal terminal including terminals along a longitudinal direction and that engages with the first internal terminal, a second insulating member supporting the second internal terminal, and second external terminals at two ends of the second internal terminal in the longitudinal direction.
(Continued)



The first connector includes projecting portions that project further toward the second connector than the first internal terminal does in a fitting direction. The second connector includes recesses that accommodate the projecting portions and guiding portions, each being in a vicinity of one of the recesses.

**18 Claims, 8 Drawing Sheets**

(51) **Int. Cl.**

| | |
|---|---|
| ***H01R 13/6592*** | (2011.01) |
| *H01R 107/00* | (2006.01) |
| *H01R 24/58* | (2011.01) |
| *H01R 24/86* | (2011.01) |
| *H01R 12/77* | (2011.01) |
| *H01R 12/78* | (2011.01) |
| *H01R 12/79* | (2011.01) |
| *H01R 12/73* | (2011.01) |
| *H01R 13/642* | (2006.01) |
| *H01R 12/52* | (2011.01) |
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| *H01R 12/70* | (2011.01) |

(52) **U.S. Cl.**

CPC ..... *H01R 12/62* (2013.01); *H01R 12/7082* (2013.01); *H01R 12/71* (2013.01); *H01R 12/716* (2013.01); *H01R 12/73* (2013.01); *H01R 12/77* (2013.01); *H01R 12/78* (2013.01); *H01R 12/79* (2013.01); *H01R 13/642* (2013.01); *H01R 24/58* (2013.01); *H01R 24/86* (2013.01); *H01R 2107/00* (2013.01)

(58) **Field of Classification Search**

CPC ..... H01R 12/78; H01R 24/58; H01R 24/86; H01R 12/52; H01R 12/62; H01R 12/71; H01R 12/77

USPC ..... 439/74, 347, 345

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 2006/0264074 | A1* | 11/2006 | Chang | H01R 12/707 439/74 |
| 2010/0291776 | A1* | 11/2010 | Huang | H01R 12/716 439/74 |
| 2013/0330943 | A1* | 12/2013 | Sasaki | H01R 12/716 439/74 |
| 2014/0363991 | A1* | 12/2014 | Ryan | H01R 12/73 439/74 |
| 2016/0315430 | A1* | 10/2016 | Takeuchi | H01R 12/00 |

FOREIGN PATENT DOCUMENTS

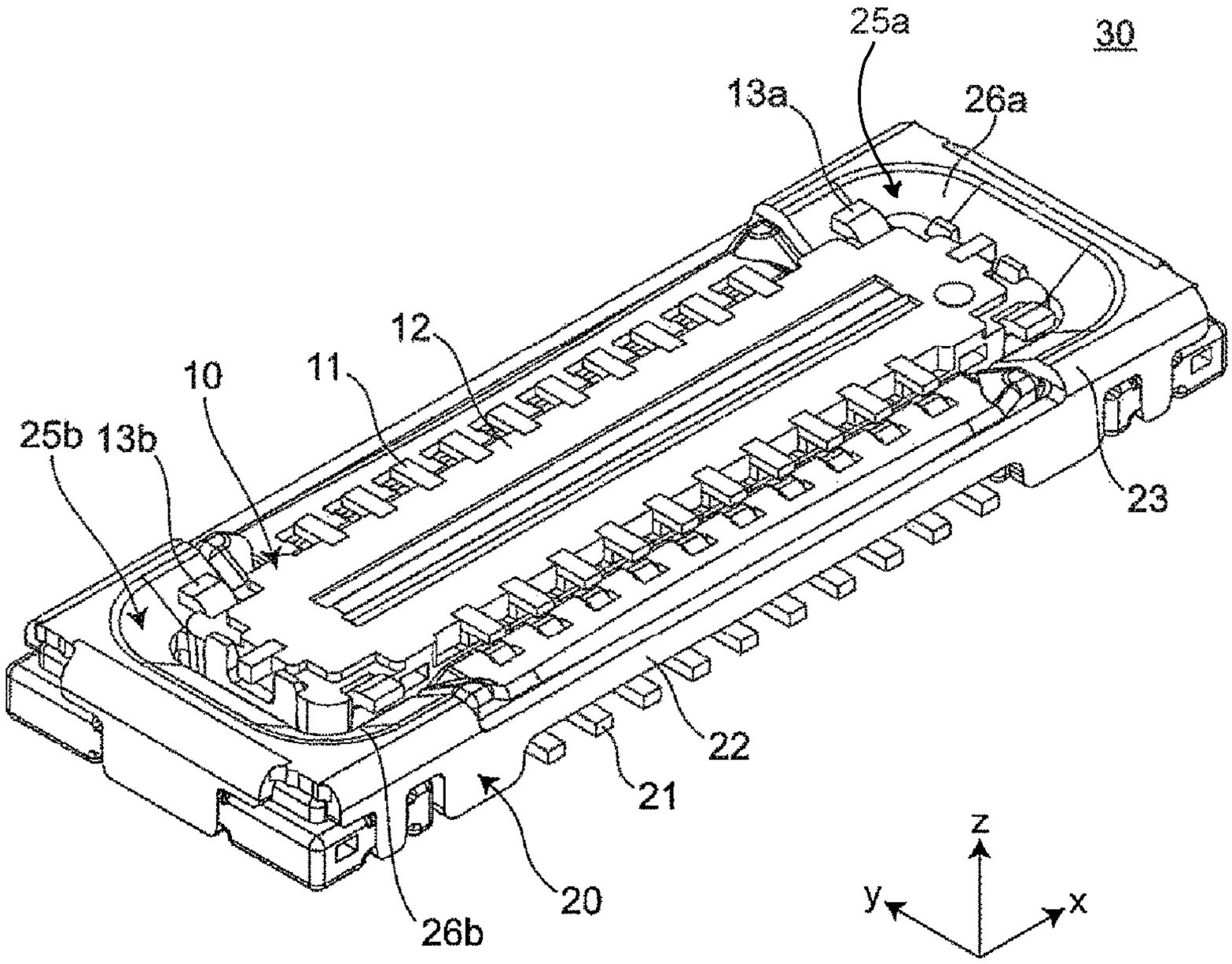
| | | | |
|---|---|---|---|
| JP | 2016-085994 | A | 5/2016 |
| JP | 2016-129148 | A | 7/2016 |
| JP | 2017-007793 | A | 1/2017 |
| JP | 2017-016891 | A | 1/2017 |
| JP | 2017-016897 | A | 1/2017 |

OTHER PUBLICATIONS

International Preliminary Report on Patentability and Written Opinion issued in PCT/JP2018/020057; dated Jan. 28, 2020.

* cited by examiner

FIG. 1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22
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z
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x

FIG. 2

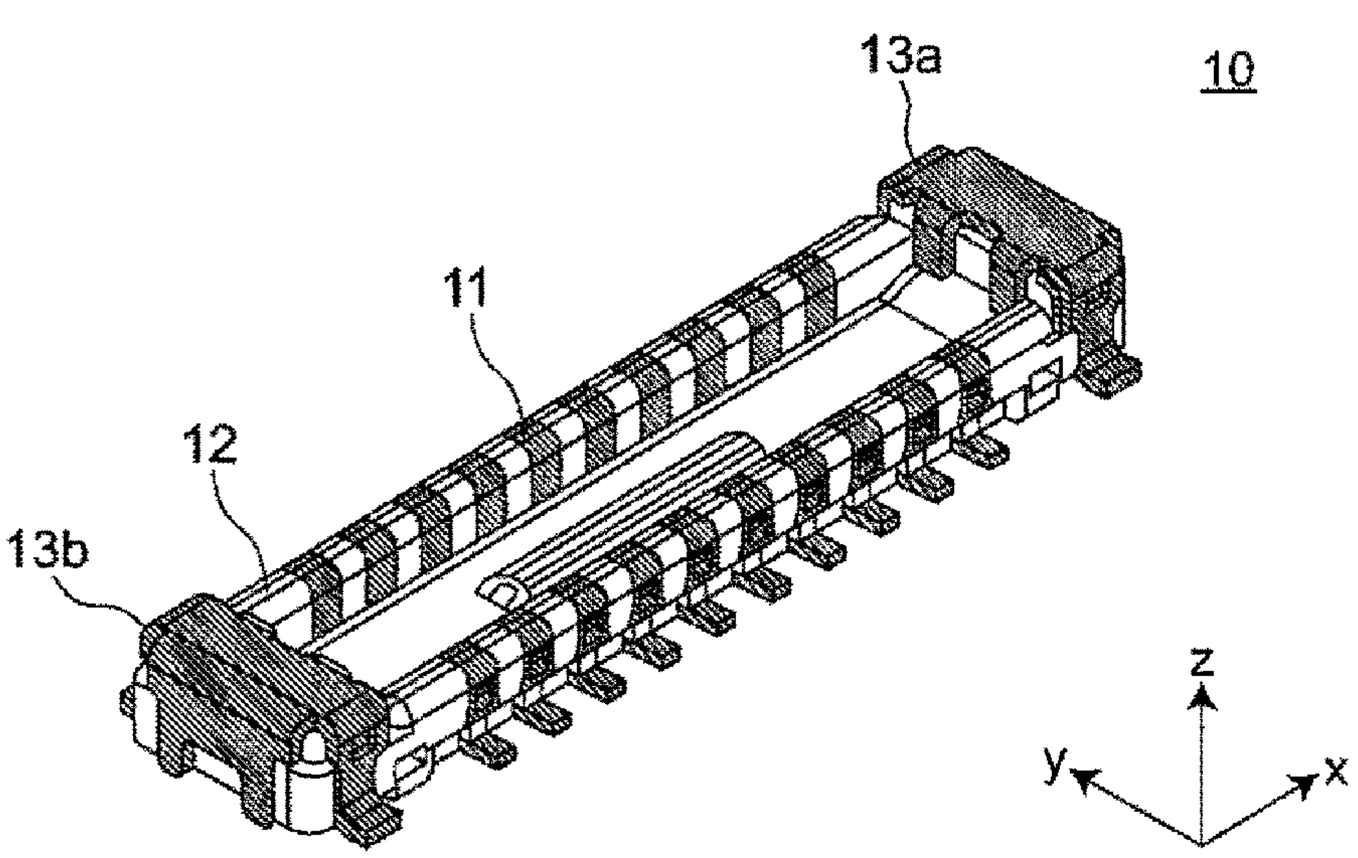
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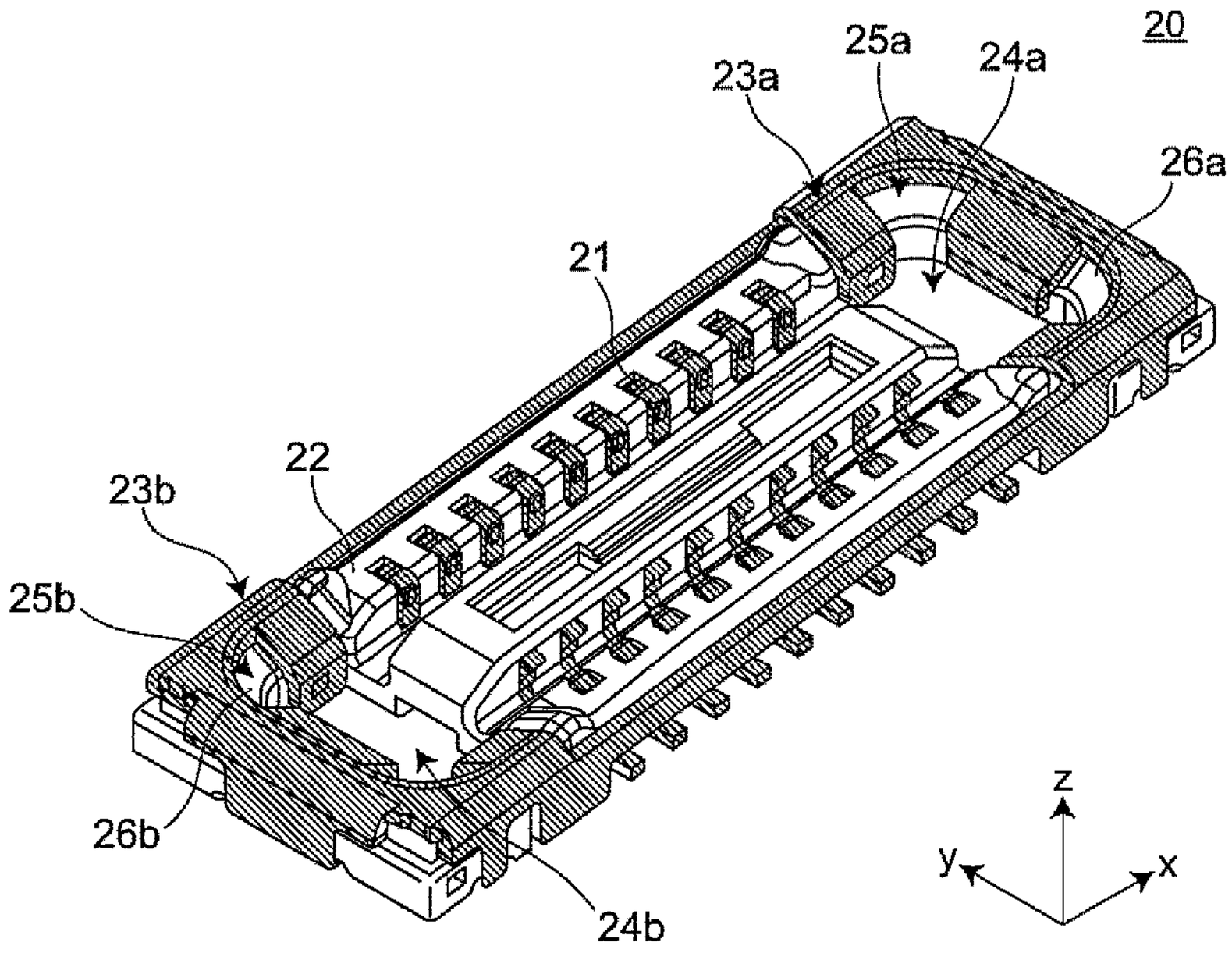
FIG. 3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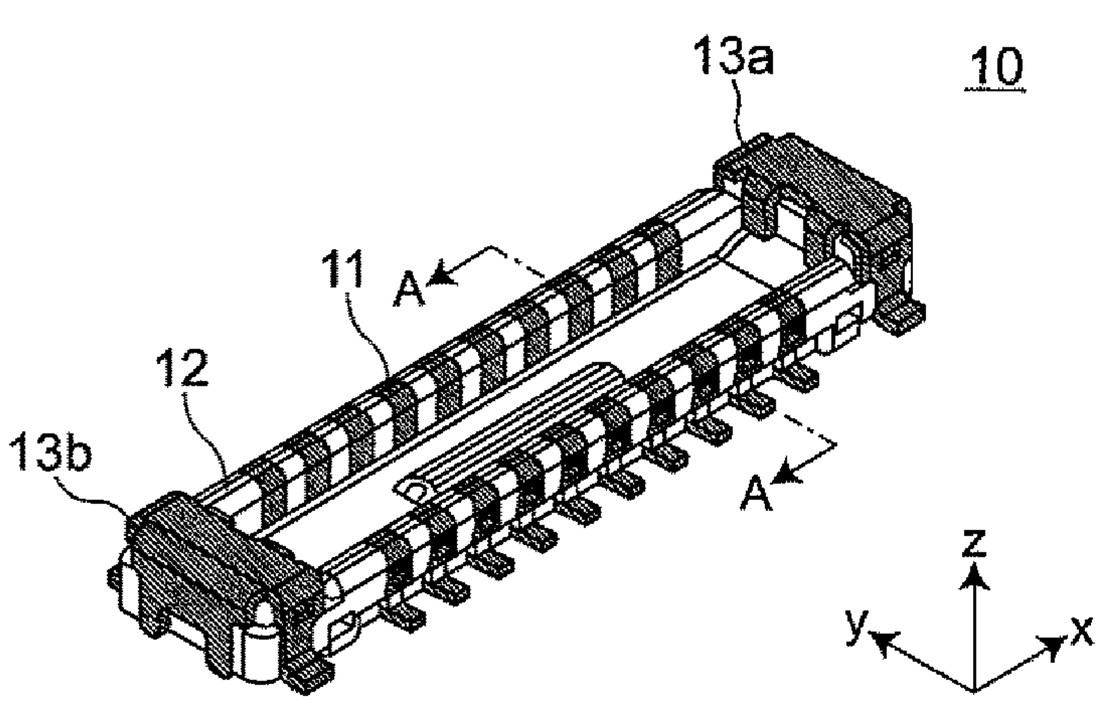
x

FIG. 4A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10
11
A
12
13b
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z
y
x

FIG. 4B

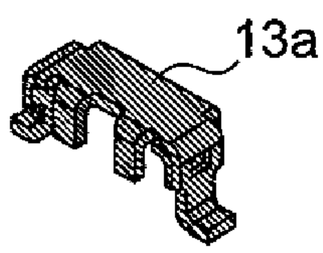


FIG. 4C

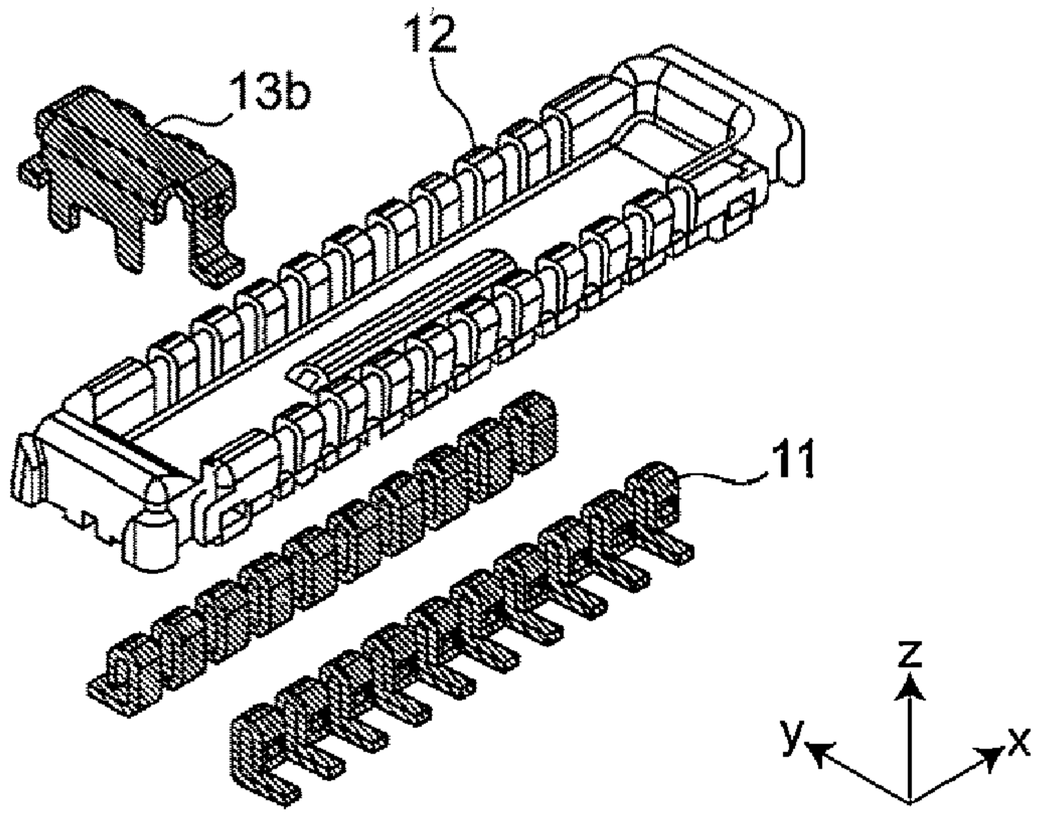


FIG. 4D

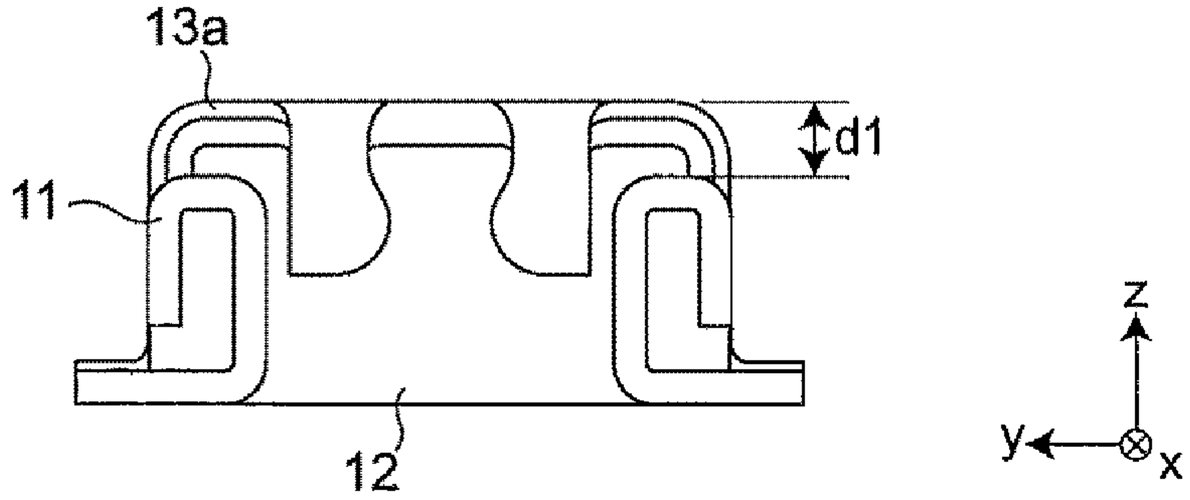

FIG. 5A

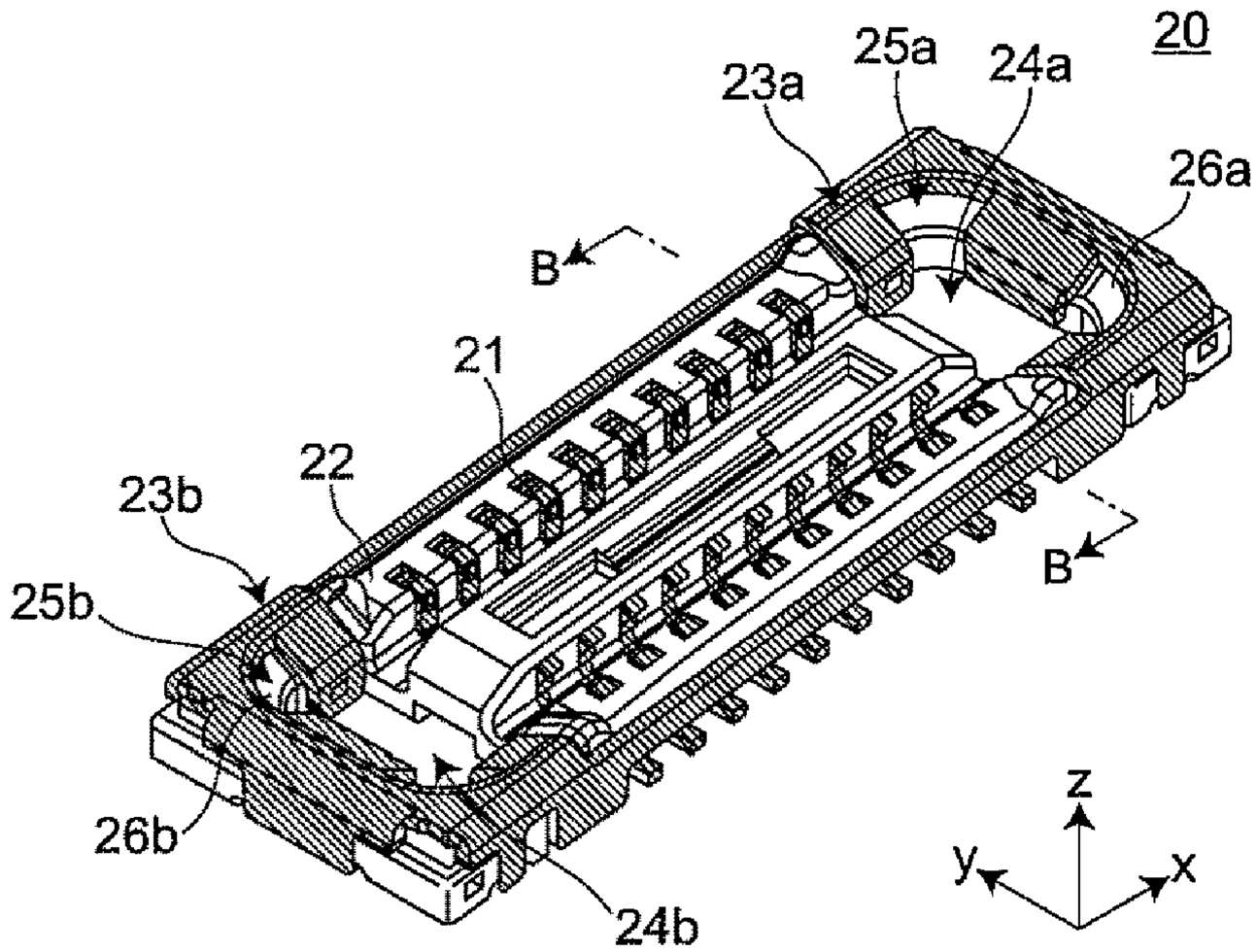

FIG. 5B

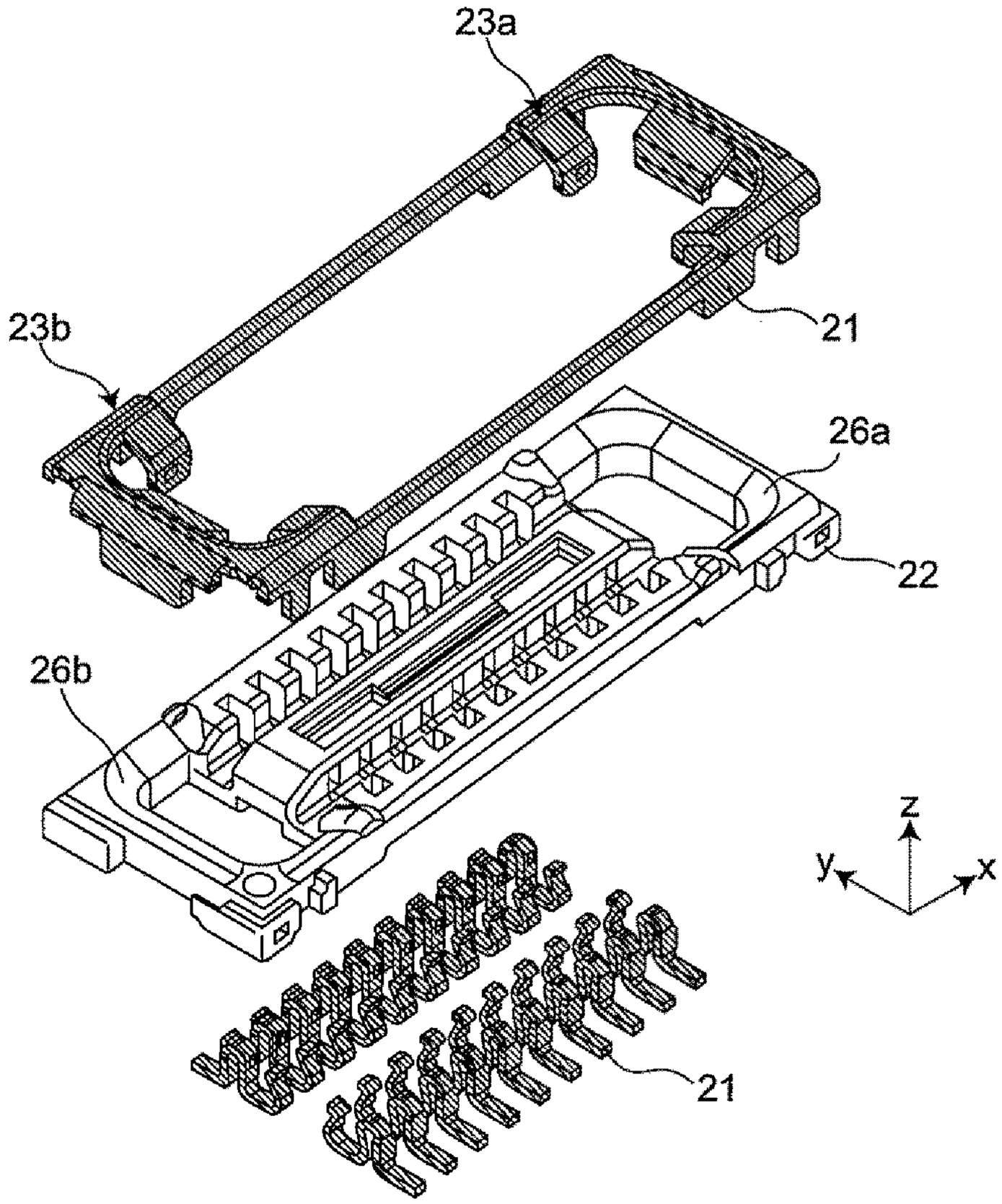


FIG. 5C

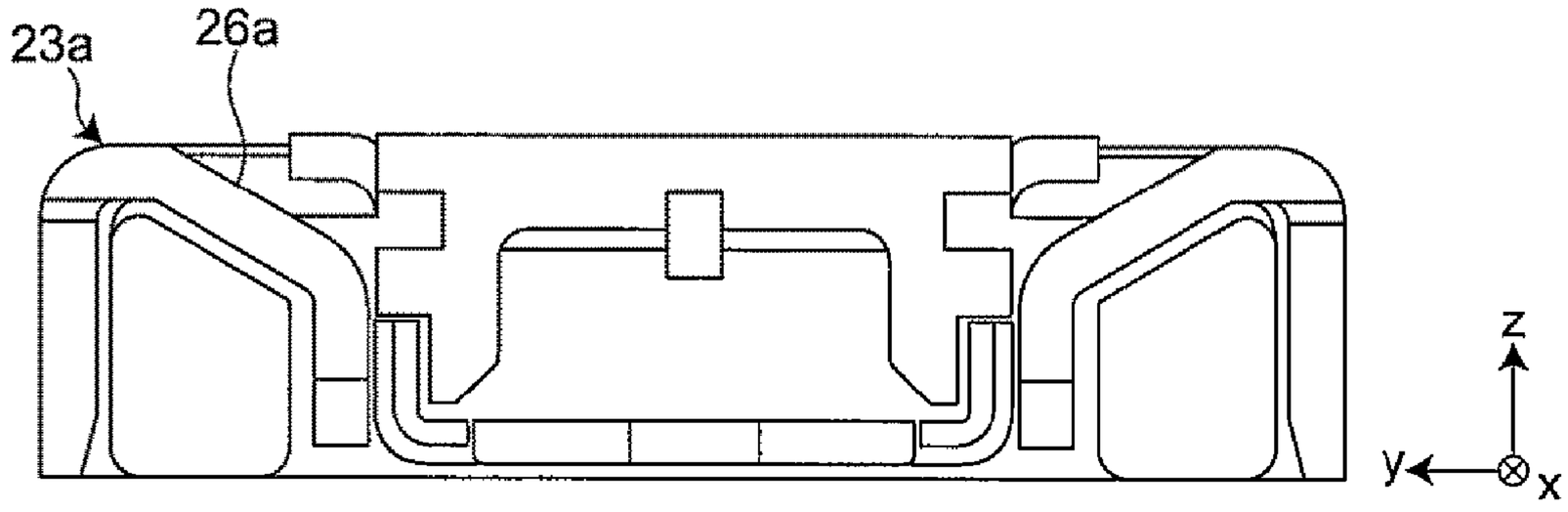

FIG. 6A

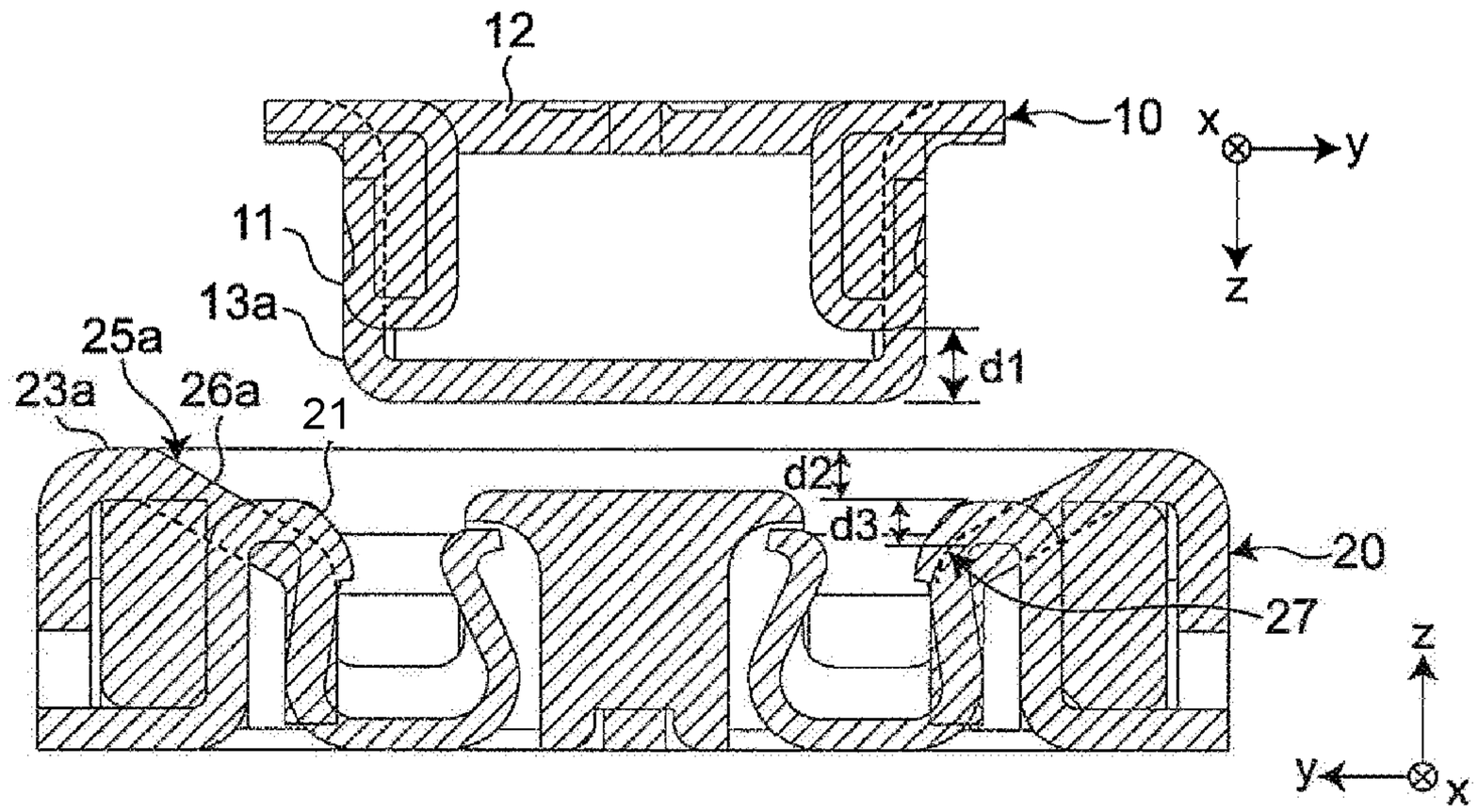


FIG. 6B

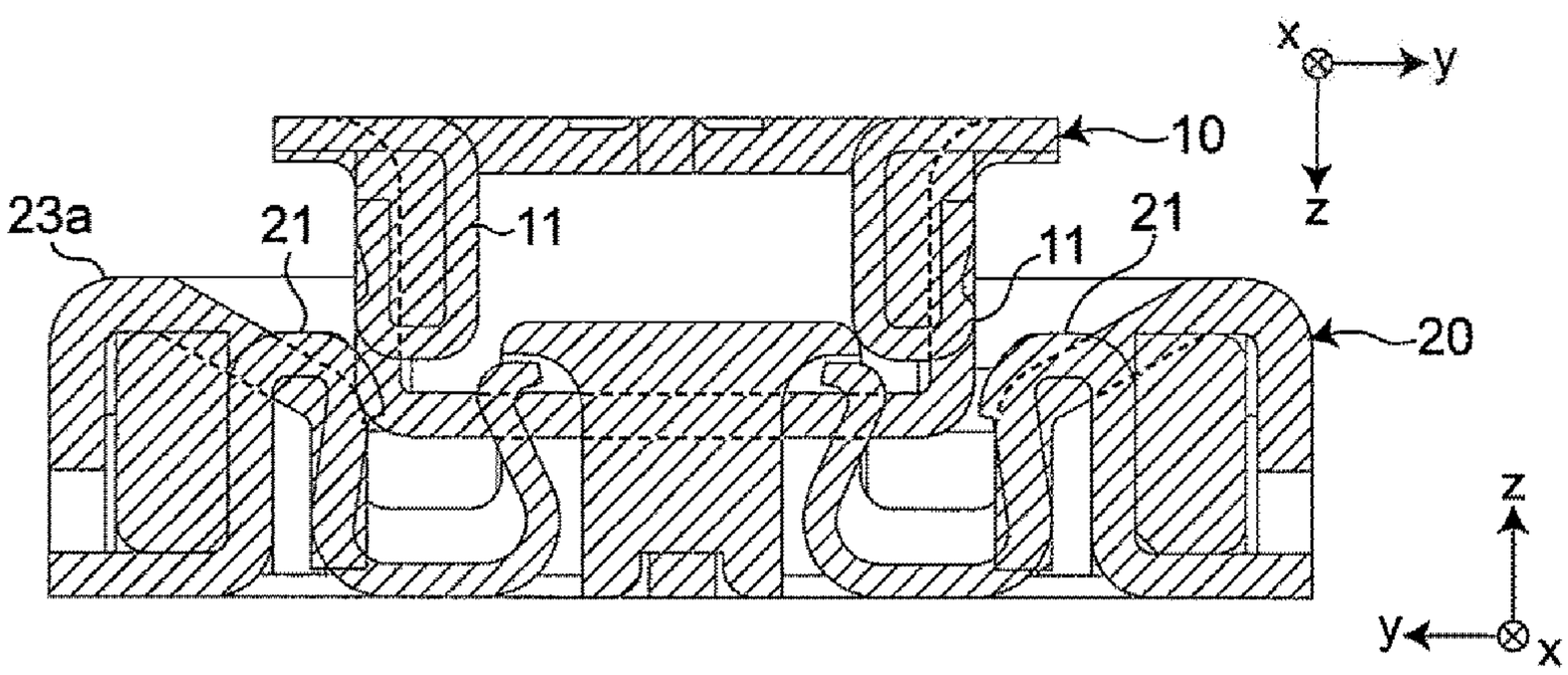


FIG. 6C

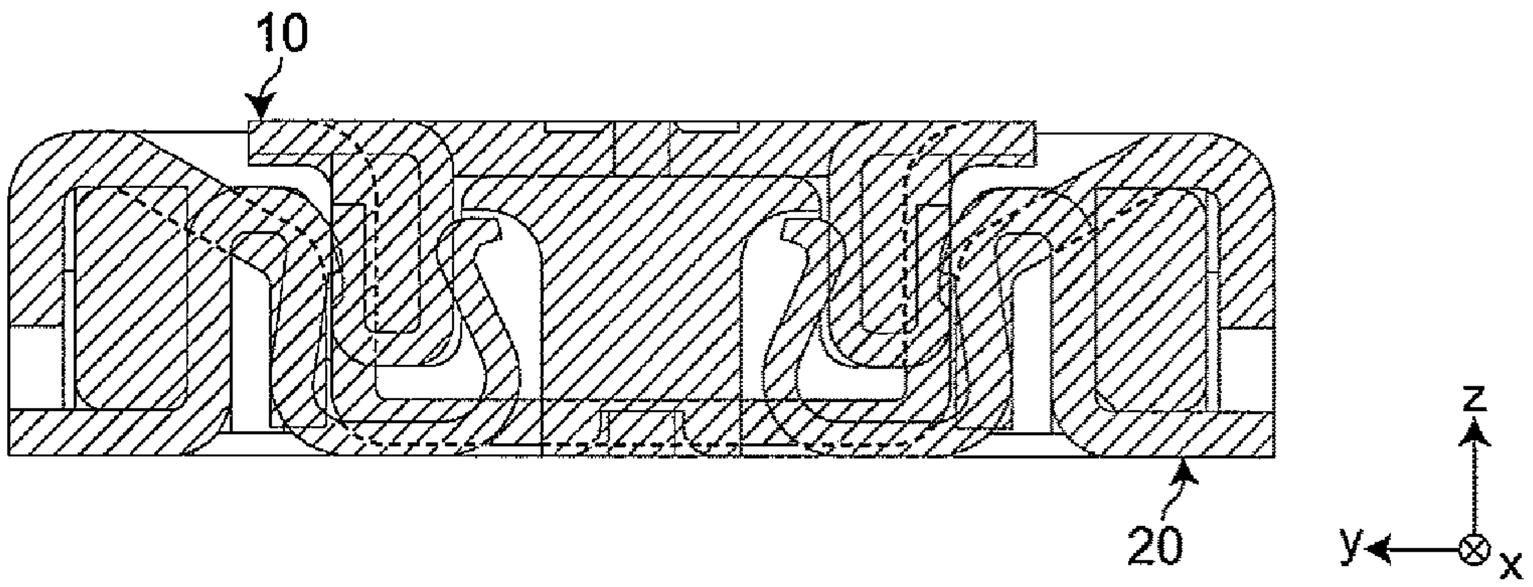

FIG. 7A

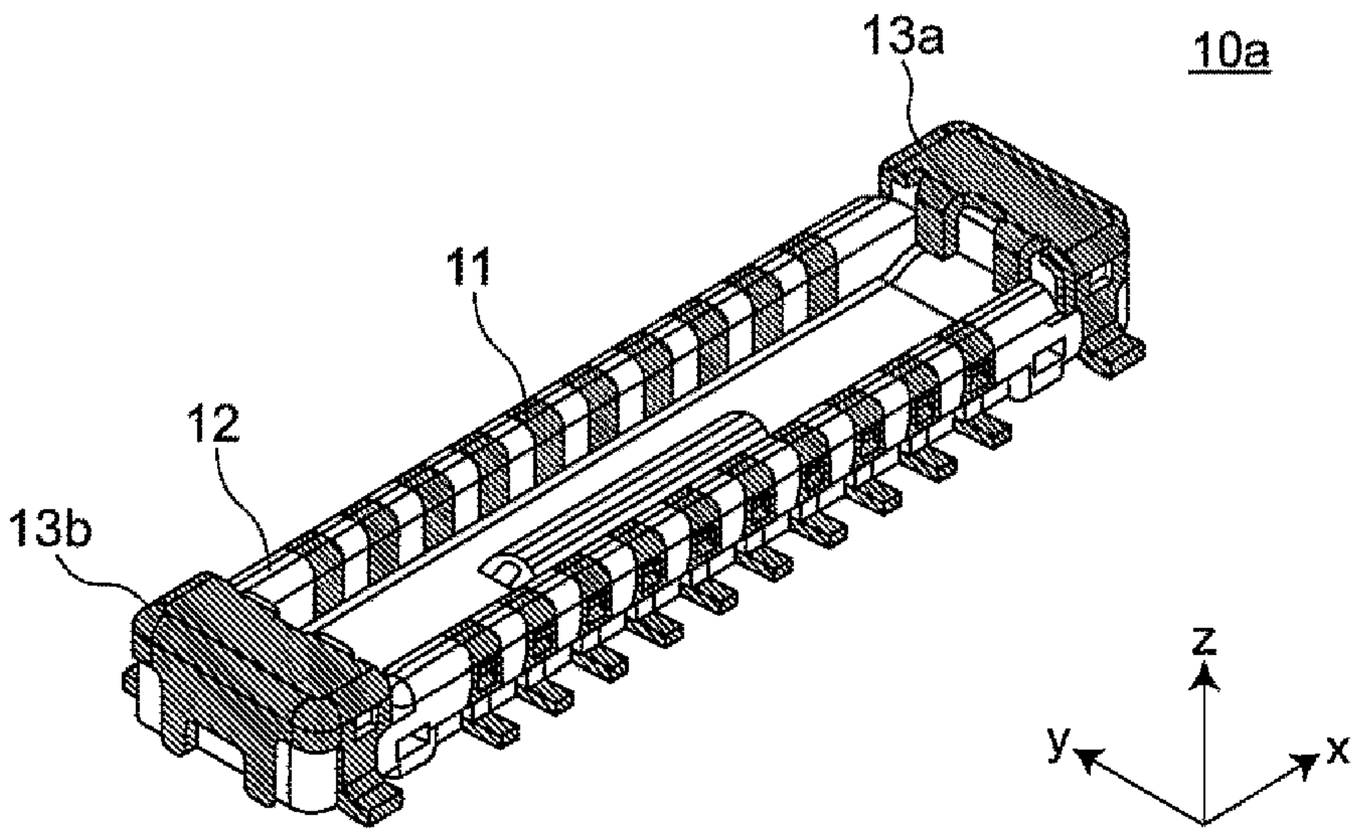


FIG. 7B

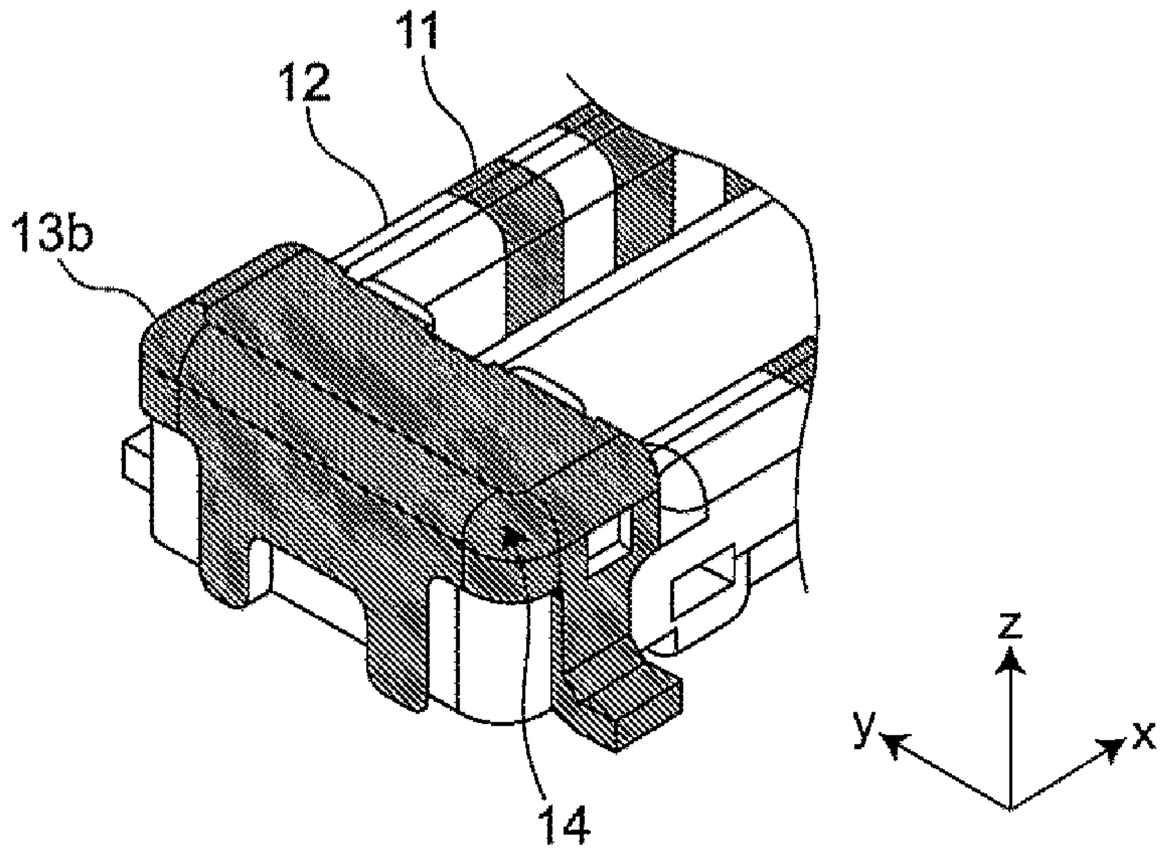

FIG. 8A

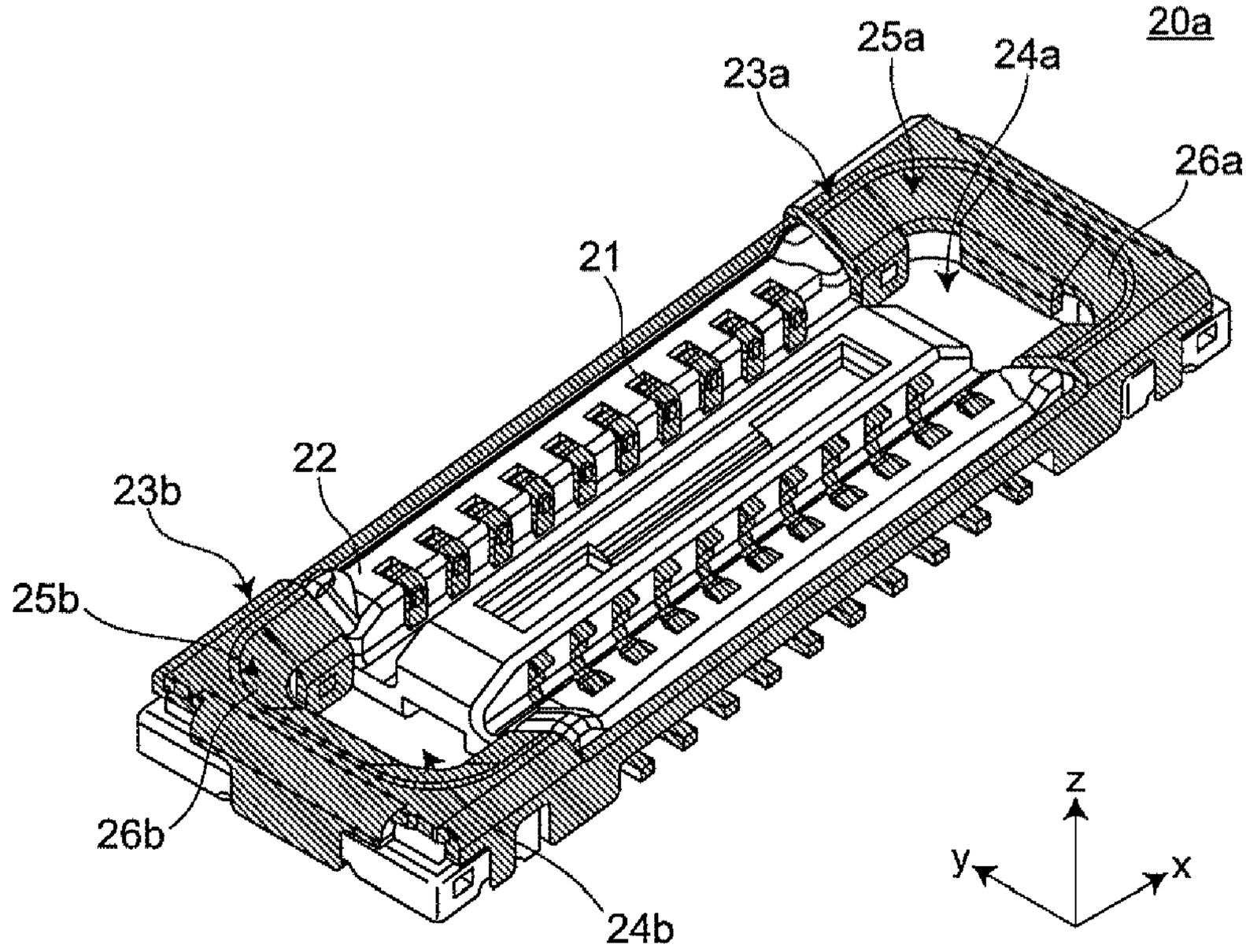
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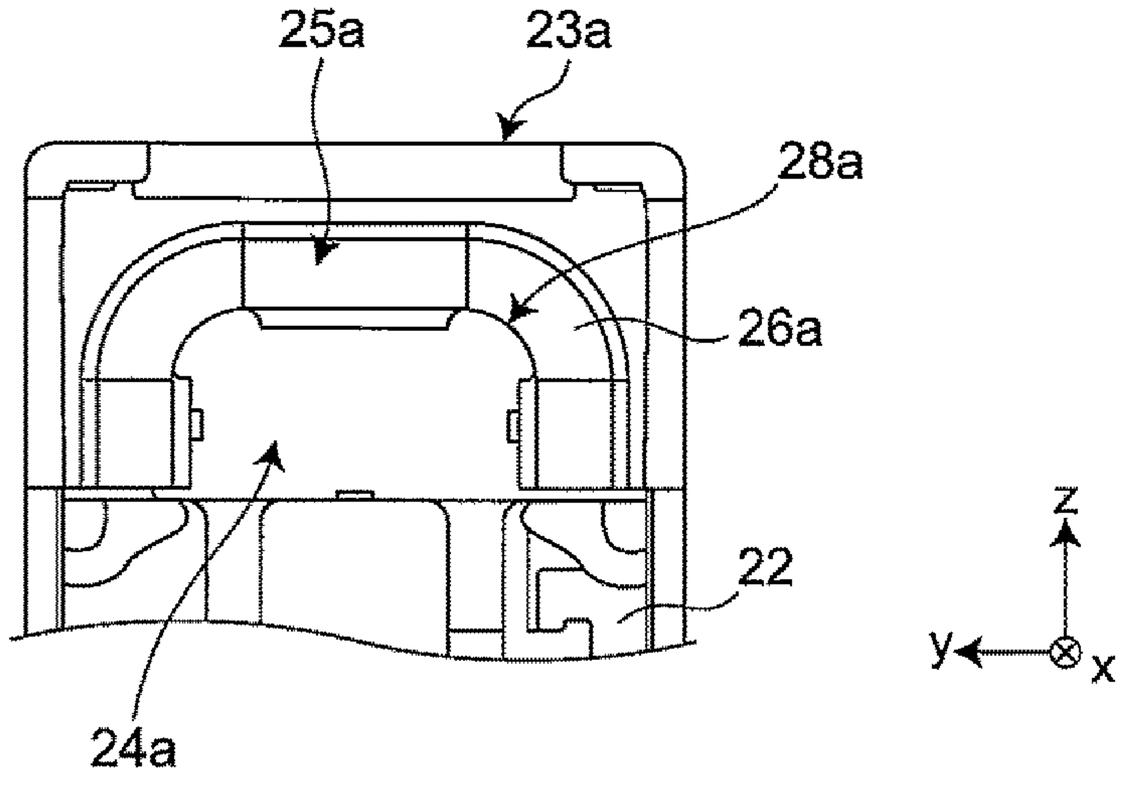
FIG. 8B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# BOARD-TO-BOARD ELECTRICAL CONNECTOR SET HAVING PROJECTING PORTIONS AND GUIDING PORTIONS

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims benefit of priority to International Patent Application No. PCT/JP2018/020057, filed May 24, 2018, and to Japanese Patent Application No. 2017-142562, filed Jul. 24, 2017, the entire contents of each are incorporated herein by reference.

## BACKGROUND

### Technical Field

The present embodiment relates to a connector set which includes a first connector having a first internal terminal and a second connector having a second internal terminal that engages with the first internal terminal.

### Background Art

When a first connector having a male internal terminal and a second connector having a female internal terminal are fitted together, there are variations in the positioning accuracy of the first connector and the second connector, and it is difficult to correctly fit the first connector and the second connector together. Accordingly, it is known that a guiding portion that guides the male internal terminal of the first connector to a correct position is included in the second connector having the female internal terminal so as to lead the first connector to a correct position as described, for example, in Japanese Unexamined Patent Application Publication No. 2016-85994.

## SUMMARY

However, in the related art, in the first connector having the male internal terminal, a second reinforcement metal fitting that corresponds to the guiding portion of the second connector having the female internal terminal has a height lower than that of the male internal terminal in a thickness direction (a fitting direction). Thus, there is a possibility that the male internal terminal will come into contact with the female internal terminal at an incorrect position before the first connector is guided to a correct position by the guiding portion, that is, in a state where the first connector has not been guided sufficiently. Therefore, there is a possibility that any one of the internal terminals will be deformed, and in the worst case, there is a possibility that the connectors cannot be fitted together.

Accordingly, the present embodiment provides a connector set capable of suppressing internal terminals of first and second connectors from coming into contact with each other at an incorrect position when the first and second connectors are fitted together and capable of suppressing the first and second connectors from becoming unable to fit together.

A connector set according to the present embodiment includes a first connector and a second connector that can face each other to fit together. The first connector includes a first internal terminal that includes terminals along a longitudinal direction, a first insulating member that supports the first internal terminal, and first external terminals that are at two ends of the first internal terminal in the longitudinal direction. The second connector includes a second internal terminal that includes terminals along a longitudinal direction and that engages with the first internal terminal of the first connector, a second insulating member that supports the second internal terminal, and second external terminals that are at two ends of the second internal terminal in the longitudinal direction. The first connector includes projecting portions that project further toward the second connector than the first internal terminal does in a direction in which the first connector and the second connector are fitted together. The second connector includes recesses in which the projecting portions of the first connector are accommodated and guiding portions each of which is in a vicinity of one of the recesses.



In the connector set according to the present embodiment, each of the first external terminals is larger in height than the first internal terminal in the first connector. Each of the guiding portions is larger in height than the second internal terminal in the second connector. Accordingly, when the first connector and the second connector are fitted together, the first external terminals of the first connector and the guiding portions of the second connector come into contact with each other before the first and second internal terminals come into contact with each other. This makes it easier to guide the first connector to a correct position, so that deformation of the first internal terminal and the second internal terminal can be suppressed, and the probability that the first connector and the second connector may become unable to fit together can be reduced.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic perspective view illustrating a configuration of a connector set according to a first embodiment;

FIG. **2** is a schematic perspective view of a first connector included in the connector set illustrated in FIG. **1**;

FIG. **3** is a schematic perspective view of a second connector included in the connector set illustrated in FIG. **1**;

FIG. **4**A is a schematic perspective view illustrating a configuration of the first connector;

FIG. **4**B is an exploded perspective view of the first connector illustrated in FIG. **4**A;

FIG. **4**C is a schematic cross-sectional view of a sectional structure taken along line A-A of FIG. **4**A;

FIG. **5**A is a schematic perspective view illustrating a configuration of the second connector;

FIG. **5**B is an exploded perspective view of the second connector illustrated in FIG. **5**A;

FIG. **5**C is a schematic cross-sectional view of a sectional structure taken along line B-B of FIG. **5**A;

FIG. **6**A is a schematic cross-sectional view when external terminals are viewed from the side on which internal terminals are disposed, the view illustrating a state immediately before the first connector illustrated in FIG. **2** and the second connector illustrated in FIG. **3**, which are facing each other, are fitted together;

FIG. **6**B is a schematic cross-sectional view when the external terminals are viewed from the side on which the internal terminals are disposed, the view illustrating a state where the first connector illustrated in FIG. **2** and the second connector illustrated in FIG. **3** start coming into contact with each other;

FIG. **6**C is a schematic cross-sectional view when the external terminals are viewed from the side on which the internal terminals are disposed, the view illustrating a state

where the first connector illustrated in FIG. **2** and the second connector illustrated in FIG. **3** are completely fitted together in the connector set;

FIG. **7**A is a schematic perspective view illustrating a configuration of a first connector included in a connector set according to a second embodiment;

FIG. **7**B is a partially enlarged view illustrating one of first external terminals at opposite ends in FIG. **7**A;

FIG. **8**A is a schematic perspective view illustrating a configuration of a second connector included in a connector set according to a third embodiment; AND

FIG. **8**B is a partially enlarged view illustrating one of second external terminals at opposite ends in FIG. **8**A.

## DETAILED DESCRIPTION

A connector set according to a first aspect is a connector set that includes a first connector and a second connector that can face each other to fit together. The first connector includes a first internal terminal that includes terminals along a longitudinal direction, a first insulating member that supports the first internal terminal, and first external terminals that are at two ends of the first internal terminal in the longitudinal direction. The second connector includes a second internal terminal that includes terminals along a longitudinal direction and that engages with the first internal terminal of the first connector, a second insulating member that supports the second internal terminal, and second external terminals that are at two ends of the second internal terminal in the longitudinal direction. The first connector includes projecting portions that project further toward the second connector than the first internal terminal does in a direction in which the first connector and the second connector are fitted together. The second connector includes recesses in which the projecting portions of the first connector are accommodated and guiding portions each of which is in a vicinity of one of the recesses.

With the above-described configuration, in the first connector, the first external terminals include projecting portions each of which is larger in height than the first internal terminal. In the second connector, each of the guiding portions is larger in height than the second internal terminal. Accordingly, when the first connector and the second connector are fitted together, the projecting portions of the first connector and the guiding portions of the second connector come into contact with each other before the first and second internal terminals come into contact with each other. This makes it easier to guide the first connector to a correct position, so that deformation of the first internal terminal and the second internal terminal can be suppressed, and the probability that the first connector and the second connector may become unable to fit together can be reduced.

In a connector set according to a second aspect, the guiding portions may project further toward the first connector than the second internal terminal does in the direction in which the first connector and the second connector are fitted together in the above-described first aspect.

In a connector set according to a third aspect, each of the projecting portions of the first connector in the above-described first or second aspect may be provided as a portion of one of the first external terminals.

In a connector set according to a fourth aspect, each of the projecting portions of the first connector in any one of the above-described first to third aspects may be made of a metal.



With the above-described configuration, the wear resistance of each of the projecting portions of the first connector can be improved.

In a connector set according to a fifth aspect, each of the guiding portions of the second connector in any one of the above-described first to fourth aspects may have an inclined surface that is in the vicinity of one of the recesses and that is inclined toward the recess.

In a connector set according to a sixth aspect, in the direction in which the first connector and the second connector are fitted together, a difference in height between each of the projecting portions of the first connector and the first internal terminal may be equal to or larger than a difference in height between the second internal terminal of the second connector and a lower end portion of the inclined surface of each of the guiding portions in the above-described fifth aspect.

In a connector set according to a seventh aspect, each of the recesses of the second connector in any one of the above-described first to sixth aspects may be a through hole that extends through the second connector.

With the above-described configuration, the height of each of the projecting portions of the first connector can be approximately equal to the height of each of the through holes of the second connector. By increasing the height of each of the projecting portions to its limit in this manner, the efficiency of guiding the first connector can be further improved. In addition, by forming the through holes, increase in the height of a product when the first connector and the second connector are fitted together can be suppressed.

In a connector set according to an eighth aspect, each of the guiding portions of the second connector in any one of the above-described first to seventh aspects may be provided as a portion of one of the second external terminals.

In a connector set according to a ninth aspect, each of the guiding portions of the second connector in any one of the above-described first to eighth aspects may be made of a metal.

With the above-described configuration, the wear resistance of each of the guiding portions of the second connector can be improved.

In a connector set according to a tenth aspect, the first connector in any one of the above-described first to ninth aspects may include to-be-guided portions each of which is made of a metal, and the to-be-guided portions may each have three surfaces perpendicular to a fitting plane in which the first connector and the second connector are fitted together and a convex surface that connects the three surfaces in a contiguous manner.

With the above-described configuration, since the to-be-guided portions are each made of a metal, the wear resistance of each of the to-be-guided portions can be improved. In addition, since the to-be-guided portions each have the three surfaces perpendicular to the fitting plane in which the first connector and the second connector are fitted together and the convex surface that connects the three surfaces in a contiguous manner, an acceptable range of positional deviation in which the first connector can be guided is wide.

In a connector set according to an eleventh aspect, each of the to-be-guided portions of the first connector in the above-described tenth aspect may be provided as a portion of one of the first external terminals.

A connector set according to an embodiment will be described below with reference to the accompanying draw-

ings. Note that, in the drawings, members that are substantially the same as each other are denoted by the same reference signs.

## First Embodiment

<Connector Set>

FIG. **1** is a schematic perspective view illustrating the configuration of a connector set **30** according to a first embodiment. FIG. **2** is a schematic perspective view of a first connector **10** included in the connector set **30** illustrated in FIG. **1**. FIG. **3** is a schematic perspective view of a second connector **20** included in the connector set **30** illustrated in FIG. **1**. Note that, in FIG. **1** to FIG. **3**, the x-axis, the y-axis, and the z-axis that are perpendicular to one another are illustrated for convenience of description.

In the connector set **30** according to the first embodiment, the first connector **10** and the second connector **20** can face each other to fit together. The first connector **10** includes a first internal terminal **11**, a first insulating member **12**, and two first external terminals **13***a* and **13***b*. The first internal terminal **11** includes one or a plurality of protruding terminals along the longitudinal direction (the x-axis direction). The first internal terminal **11** is supported by the first insulating member **12**. The two first external terminals **13***a* and **13***b* are at the opposite ends of the first internal terminal **11** in the longitudinal direction (the x-axis direction) so as to be spaced apart from each other. The second connector **20** includes a second internal terminal **21**, a second insulating member **22**, and two second external terminals **23**, which are referred to as second external terminals **23***a* and **23***b* as indicated in FIGS. **3**, **5**A-**5**C, **6**A, **6**B, **8**A and **8**B. The second internal terminal **21** includes one or a plurality of recessed terminals along the longitudinal direction (the x-axis direction) and engages with the first internal terminal **11** of the first connector **10**. The second internal terminal **21** is supported by the second insulating member **22**. The second external terminals **23***a* and **23***b* are at the opposite ends of the second internal terminal **21** in the longitudinal direction (the x-axis direction) so as to be spaced apart from each other.

The first connector **10** includes projecting portions (the first external terminals **13***a* and **13***b*) that project further toward the second connector **20** than the first internal terminal **11** does in a direction (the z-axis direction, which is a fitting direction) perpendicular to a fitting plane (an x-y plane) in which the first connector **10** and the second connector **20** are fitted together. The second connector **20** has recesses **24***a* and **24***b* in which the projecting portions of the first connector **10** are accommodated and guiding portions **25***a* and **25***b* that are in the vicinity of the recesses **24***a* and **24***b* and that project further toward the first connector **10** than the second internal terminal **21** does in the direction (the z-axis direction) perpendicular to the fitting plane, in which the first connector **10** and the second connector **20** are fitted together.

With the above-described configuration, when the first connector **10** and the second connector **20** are fitted together, the first external terminals **13***a* and **13***b*, each of which is larger in height than the first internal terminal **11**, and the guiding portions **25***a* and **25***b*, each of which is larger in height than the second internal terminal **21**, come into contact with each other before the first and second internal terminals **11** and **21** come into contact with each other. This makes it easy to guide the first connector **10** to a correct position. In other words, a guiding efficiency at the time of fitting the connectors is improved, and smooth fitting can be performed. As a result, deformation of the first internal terminal **11** and the second internal terminal **21** can be suppressed, and the probability that the first connector **10** and the second connector **20** may become unable to fit together can be reduced.

Each member included in the connector set will be described below.

<First Connector>

FIG. **4**A is a schematic perspective view illustrating the configuration of the first connector **10**. FIG. **4**B is an exploded perspective view of the first connector **10** illustrated in FIG. **4**A. FIG. **4**C is a schematic cross-sectional view of a sectional structure taken along line A-A of FIG. **4**A. Note that, in FIG. **4**A to FIG. **4**C, the x-axis, the y-axis, and the z-axis that are perpendicular to one another are illustrated for convenience of description.

The first connector **10** includes the first internal terminal **11**, the first insulating member **12**, and the two first external terminals **13***a* and **13***b*. In addition, the first connector **10** includes the projecting portions projecting further toward the second connector **20** than the first internal terminal **11** does in the direction (the fitting direction) perpendicular to the fitting plane, in which the first connector **10** and the second connector **20** are fitted together.

<First Internal Terminal>

The first internal terminal **11** includes one or a plurality of protruding terminals along the longitudinal direction. Thus, the first internal terminal **11** is also usually called a male internal terminal. The first internal terminal **11** is, for example, a conductor that is connected to a signal potential or a ground potential and is formed by bending a bar-shaped member having electrical conductivity. In addition, for example, the first internal terminal **11** is supported by being fitted into a groove of the first insulating member **12**. For example, phosphor bronze can be used as the material of the first internal terminal **11**. Phosphor bronze is a material that has electrical conductivity and that is capable of being elastically deformed.

As illustrated in FIG. **4**A, the first internal terminal **11** includes two rows of protruding terminals extending in the longitudinal direction, and each of the rows includes ten protruding terminals. Note that the number of the rows is not limited to two, and three or more rows may be provided. In order to suppress interference of electromagnetic waves between the rows included in the first internal terminal **11**, an electrically conductive shield member (not illustrated) may be provided between the rows in the first internal terminal **11**. For example, the shield member may be supported by being fitted into a center groove of the first insulating member **12**. In addition, the shield member may extend in the longitudinal direction between the rows in the first internal terminal **11**.

Note that, in the present embodiment, although one or a plurality of protruding terminals are in the first internal terminal **11**, the first internal terminal **11** is not limited to having this configuration, and one or a plurality of recessed terminals may be arranged. In this case, in the second internal terminal **21** that engages with the first internal terminal **11**, one or a plurality of protruding terminals are arranged instead of one or a plurality of recessed terminals.

<First External Terminals>

The first external terminals **13***a* and **13***b* are at the opposite ends of the first internal terminal **11** in the longitudinal direction so as to be spaced apart from each other. Note that, as illustrated in FIG. **4**A and FIG. **4**B, although the two first external terminals **13***a* and **13***b* are isolated from each other, the present embodiment is not limited to this

configuration, and the first external terminals **13***a* and **13***b* may be connected to each other. In this case, the first external terminals **13***a* and **13***b* may be a continuous member.

For example, the first external terminals **13***a* and **13***b* are conductors that are connected to the ground potential. The first external terminals **13***a* and **13***b* are maintained at the ground potential by being connected to the ground potential, so that the first external terminals **13***a* and **13***b* block radio waves from the outside of the first connector **10** and can form an electrically shielded space in the first connector **10**. In other words, the first external terminals **13***a* and **13***b* are also particularly useful as members that prevent the radio waves from the outside of the first connector **10** from interfering with the first internal terminal **11**. For example, phosphor bronze can be used as the material of the first external terminals **13***a* and **13***b*. Phosphor bronze is a material that has electrical conductivity and that is capable of being elastically deformed. Note that, surfaces of the first external terminals **13***a* and **13***b* may be coated with, for example, gold. For example, the first external terminals **13***a* and **13***b* are formed by bending.

<First Insulating Member>

The first insulating member **12** supports the first internal terminal **11** and also supports the first external terminals **13***a* and **13***b* integrally. For example, a resin such as a liquid crystal polymer may be used as the material of the first insulating member **12**. A resin case may be formed as the first insulating member **12**. In addition, for example, the first internal terminal **11** and the first external terminals **13***a* and **13***b* may be integrally molded with the first insulating member **12**, which is made of a resin, into the single first connector **10** by insert molding.

<Projecting Portions>

As illustrated in the cross-sectional view in FIG. **4**C, each of the first external terminals **13***a* and **13***b* is a projecting portion that projects toward the second connector **20** by a projection amount d**1** relative to the first internal terminal **11** in the direction perpendicular to the fitting plane, in which the first connector **10** and the second connector **20** are fitted together. In other words, the projecting portions are provided as portions of the first external terminals **13***a* and **13***b*. The first external terminals **13***a* and **13***b* are each formed to have a large height in a thickness direction (the z-axis direction) in order to improve the guiding efficiency.

Note that the projecting portions are not limited to being provided as portions of the above-mentioned first external terminals and may be provided as members that are different from the first external terminals. In addition, the projecting portions are not limited to being made of a metal and may be made of a resin.

<Second Connector>

FIG. **5**A is a schematic perspective view illustrating the configuration of the second connector **20**. FIG. **5**B is an exploded perspective view of the second connector **20** illustrated in FIG. **5**A. FIG. **5**C is a schematic cross-sectional view of a sectional structure taken along line B-B of FIG. **5**A. Note that, in FIG. **5**A to FIG. **5**C, the x-axis, the y-axis, and the z-axis that are perpendicular to one another are illustrated for convenience of description.

The second connector **20** includes the second internal terminal **21**, the second insulating member **22**, and the second external terminals **23***a* and **23***b*. The second connector **20** surrounds the first connector **10** from the outside and has a size larger than that of the first connector **10**.

The second connector has the recesses **24***a* and **24***b* in which the projecting portions of the first connector **10** are accommodated and the guiding portions **25***a* and **25***b* that are in the vicinity of the recesses **24***a* and **24***b* and that project further toward the first connector **10** than the second internal terminal **21** does in the direction perpendicular to the fitting plane, in which the first connector **10** and the second connector **20** are fitted together.

<Second Internal Terminal>

The second internal terminal **21** includes one or a plurality of recessed terminals along the longitudinal direction. Thus, the second internal terminal **21** is also usually called a female internal terminal. The second internal terminal engages with the first internal terminal **11** of the first connector **10**. The second internal terminal **21** is, for example, a conductor that is connected to a signal potential or a ground potential and is formed by bending a bar-shaped member having electrical conductivity. In addition, for example, the second internal terminal **21** is supported by being fitted into a groove of the second insulating member **22**. For example, phosphor bronze can be used as the material of the second internal terminal **21**. Phosphor bronze is a material that has electrical conductivity and that is capable of being elastically deformed.

As illustrated in FIG. **5**A, the second internal terminal **21** includes two rows of recessed terminals extending in the longitudinal direction, and each of the rows includes ten recessed terminals. Note that the number of the rows is not limited to two, and three or more rows may be provided. The recessed terminals come into contact and engage with the protruding terminals of the first internal terminal **11** in a one-to-one relationship. When engaging, inner end portions of the recessed terminals are opened so as to engage with the protruding terminals. In order to suppress interference of electromagnetic waves between the rows included in the second internal terminal **21**, an electrically conductive shield member (not illustrated) may be provided between the rows in the second internal terminal **21**. For example, the shield member may be supported by being fitted into a center groove of the second insulating member **22**. In addition, the shield member may extend in the longitudinal direction between the rows in the second internal terminal **21**.

Note that, in the present embodiment, although one or a plurality of recessed terminals are in the second internal terminal **21**, the second internal terminal **21** is not limited to having this configuration, and one or a plurality of protruding terminals may be arranged. In this case, in the first internal terminal **11** that engages with the second internal terminal **21**, one or a plurality of recessed terminals are arranged instead of one or a plurality of protruding terminals.

The second external terminals **23***a* and **23***b* are at the opposite ends of the second internal terminal **21** in the longitudinal direction (the x-axis direction) so as to be spaced apart from each other. Note that, as illustrated in FIG. **5**A and FIG. **5**B, although the second external terminals **23***a* and **23***b* are in an annular shape so as to surround the second connector **20**, the present embodiment is not limited to this configuration, and for example, the second external terminals **23***a* and **23***b* may be separated into two portions that are provided at opposite ends.

For example, the second external terminals **23***a* and **23***b* are conductors that are connected to the ground potential. The second external terminals **23***a* and **23***b* are maintained at the ground potential by being connected to the ground potential, so that the second external terminals **23***a* and **23***b* block radio waves from the outside of the second connector **20** and can form an electrically shielded space in the second connector **20**. In other words, the second external terminals

**23***a* and **23***b* are also particularly useful as members that prevent the radio waves from the outside of the second connector **20** from interfering with the second internal terminal **21**. For example, phosphor bronze can be used as the material of the second external terminals **23***a* and **23***b*. Phosphor bronze is a material that has electrical conductivity and that is capable of being elastically deformed. For example, the second external terminals **23***a* and **23***b* are formed by bending.

<Second Insulating Member>

The second insulating member **22** supports the second internal terminal **21** and also supports the second external terminals **23***a* and **23***b* integrally. For example, a resin may be used as the material of the second insulating member **22**. The second internal terminal **21** may be built into the second insulating member **22** by press fitting. Alternatively, for example, the second internal terminal **21** and the second external terminals **23***a* and **23***b* may be integrally molded with the second insulating member **22**, which is made of a resin, into the single second connector **20** by insert molding.

<Recesses>

The first external terminals **13***a* and **13***b*, which are the projecting portions of the first connector **10**, are accommodated in the recesses **24***a* and **24***b*, respectively. Note that each of the recesses **24***a* and **24***b* may be a hole having a resin bottom or may be a through hole that does not have a resin bottom. By forming the recesses **24***a* and **24***b* as through holes, the height of each of the first external terminals **13***a* and **13***b*, which are the projecting portions of the first connector **10**, can be approximately equal to the height of each of the through holes of the second connector **20**. By increasing the height of each of the projecting portions to its limit in this manner, the efficiency of guiding the first connector **10** can be further improved. In addition, by forming such through holes, the through holes can accommodate the height of each of the first external terminals **13***a* and **13***b*, which are the projecting portions of the first connector **10**, and thus, the height of a product (the connector set) can be suppressed from becoming unnecessarily large when the first connector **10** and the second connector **20** are fitted together.

<Guiding Portions (Leading Portions)>

The guiding portions **25***a* and **25***b* are in the vicinity of the recesses **24***a* and **24***b* and project further toward the first connector **10** than the second internal terminal **21** does in the direction perpendicular to the fitting plane, in which the first connector **10** and the second connector **20** are fitted together. In other words, the guiding portions **25***a* and **25***b* are each formed to have a large height in the thickness direction (the z-axis direction) in order to improve the efficiency of guiding the first connector **10**.

In addition, as illustrated in FIG. **5**A, in the second connector **20** included in the connector set **30**, the guiding portions **25***a* and **25***b* are respectively formed of the second external terminals **23***a* and **23***b*, which are made of a metal, such that the guiding portion **25***a* extends in a discontinuous manner along three sides (a short side (the y-axis) and portions of long sides at the opposite ends of the short side) at one of the two ends in the longitudinal direction (the x-axis direction) and such that the guiding portion **25***b* extends in a discontinuous manner along other three sides (a short side (the y-axis) and portions of long sides at the opposite ends of the short side) at the other of the two ends in the longitudinal direction. The present embodiment is not limited to this configuration, and as in a third embodiment, which will be described later, each of the guiding portions **25***a* and **25***b* may be provided so as to have three contiguous sides at one of the two ends in the longitudinal direction (the x-axis direction). In addition, each of the guiding portions **25***a* and **25***b* is not limited to being made of a metal and may be formed of a resin member. Alternatively, each of the guiding portions **25***a* and **25***b* may include a portion made of a metal and a portion made of a resin.

<Fitting of First Connector and Second Connector>

FIG. **6**A is a schematic cross-sectional view when the first external terminal **13***a* and the second external terminal **23***a* are viewed from the side on which the first internal terminal **11** and the second internal terminal **21** are disposed, the view illustrating a state immediately before the first connector **10** illustrated in FIG. **2** and the second connector **20** illustrated in FIG. **3**, which are facing each other, are fitted together. FIG. **6**B is a schematic cross-sectional view when the first external terminal **13***a* and the second external terminal **23***a* are viewed from the side on which the first internal terminal **11** and the second internal terminal **21** are disposed, the view illustrating a state where the first connector **10** illustrated in FIG. **2** and the second connector **20** illustrated in FIG. **3** start coming into contact with each other. FIG. **6**C is a schematic cross-sectional view when the first external terminal **13***a* and the second external terminal **23***a* are viewed from the side on which the first internal terminal **11** and the second internal terminal **21** are disposed, the view illustrating a state where the first connector **10** illustrated in FIG. **2** and the second connector **20** illustrated in FIG. **3** of the connector set **30** are completely fitted together. Note that, in FIG. **6**A to FIG. **6**C, the x-axis, the y-axis, and the z-axis that are perpendicular to one another are illustrated for convenience of description. Note that the first connector **10** and the second connector **20** are fitted together such that the z-axis of the first connector **10** and the z-axis of the second connector **20** oppose each other. Thus, when the first connector **10** and the second connector **20** are fitted together, the y-axis of the first connector **10** and the y-axis of the second connector **20** are oriented in opposite directions, and the z-axis of the first connector **10** and the z-axis of the second connector **20** are oriented in opposite directions.

A state when the first connector **10** and the second connector **20** are fitted together will be described below with reference to FIG. **6**A to FIG. **6**C.

(1) The first connector **10** and the second connector **20** are arranged such that the z-axis of the first connector **10** and the z-axis of the second connector **20** oppose each other (FIG. **6**A). As illustrated in FIG. **6**A, the first external terminal **13***a* of the first connector **10** projects toward the second connector **20** by the projection amount d**1** relative to the first internal terminal **11** in the direction (the z-axis direction, which is the fitting direction) perpendicular to the fitting plane (the x-y plane), in which the first connector **10** and the second connector **20** are fitted together. The second external terminal **23***a* of the second connector **20** projects toward the first connector **10** by a projection amount d**2** relative to the second internal terminal **21** in the direction (the z-axis direction) perpendicular to the fitting plane (the x-y plane), in which the first connector **10** and the second connector **20** are fitted together. It is preferable that the projection amount d**1** of the first external terminal **13***a* and the projection amount d**2** of the second external terminal **23***a* be substantially similar to each other. The guiding portion **25***a* of the second connector **20** has an inclined surface **26***a*, and a lower end portion **27** of the inclined surface **26***a* is lower than the second internal terminal **21** by a height difference d**3** in the z-axis direction. Likewise, as further shown, the guiding portion **25***b* of the second connector **20** has an

inclined surface **26***b* having features similar to those of inclined surface **26***a* as discussed herein.

(2) Next, the first external terminal **13***a* of the first connector **10** is guided along the inclined surface **26***a* of the guiding portion **25***a*, which is a portion of the second external terminal **23***a* of the second connector **20**, to the lower end portion **27** (FIG. **6**B). In other words, when the first connector **10** and the second connector **20** are fitted together, the guiding portions **25***a* and **25***b* are brought into contact with the first external terminals **13***a* and **13***b*, which are to-be-guided portions, so as to be positioned, and then, the first internal terminal **11** and the second internal terminal **21** engage each other. As illustrated in FIG. **6**B, the first external terminal **13***a* of the first connector **10** is guided along the inclined surface **26***a* of the guiding portion **25***a* of the second connector **20** to the lower end portion **27**. At this point, it is preferable that the first internal terminal **11** of the first connector **10** and the second internal terminal **21** of the second connector **20** come into contact with each other. Consequently, it is preferable that the projection amount d**1** of the first external terminal **13***a* be larger than the height difference d**3** between the lower end portion **27** of the inclined surface **26***a* of the guiding portion **25***a* and the second internal terminal **21**.

(3) After that, the first internal terminal **11** of the first connector **10** and the second internal terminal **21** of the second connector **20** engage each other so as to connect the first connector **10** to the second connector **20** in the connector set **30**.

In the manner described above, the connector set **30** includes the first connector **10** and the second connector **20** that are configured to face each other to fit together.

## Second Embodiment

FIG. **7**A is a schematic perspective view illustrating a configuration of a first connector included in a connector set according to a second embodiment. FIG. **7**B is a partially enlarged view illustrating one of first external terminals at opposite ends in FIG. **7**A. Note that, in FIG. **7**A and FIG. **7**B, the x-axis, the y-axis, and the z-axis that are perpendicular to one another are illustrated for convenience of description.

When comparing a first connector **10***a* included in the connector set according to the second embodiment and the first connector included in the connector set according to the first embodiment, the difference between the first connector **10***a* and the first connector is that, in the first connector **10***a*, the first external terminals **13***a* and **13***b*, which are to-be-guided portions, each have three surfaces that are perpendicular to a fitting plane in which the first connector **10***a* and the second connector **20** are fitted together and a convex surface **14** that connects the three surfaces in a contiguous manner. In other words, the first external terminals **13***a* and **13***b*, which are to-be-guided portions, are each formed so as to continuously extend from three outer side surfaces of the first connector **10** to the upper surface of the first connector **10** and so as to extend across the adjacent outer side surfaces of the first connector **10** such that end portions (corner portions) of the first insulating member (a resin case) **12** of the first connector **10** are not exposed. As a result, the guiding efficiency when the first connector **10***a* and the second connector **20** are fitted together is improved, and deformation or breakage of the second connector **20** can be suppressed.

Note that the above-mentioned convex surface **14** may be formed by drawing or the like.

## Third Embodiment

FIG. **8**A is a schematic perspective view illustrating a configuration of a second connector **20***a* included in a connector set according to the third embodiment. FIG. **8**B is a partially enlarged view illustrating the second external terminal **23***a*, which is one of the second external terminals **23***a* and **23***b* at opposite ends in FIG. **8**A. Note that, in FIG. **8**A and FIG. **8**B, the x-axis, the y-axis, and the z-axis that are perpendicular to one another are illustrated for convenience of description.

When comparing the second connector **20***a* included in the connector set according to the third embodiment and the second connector included in the connector set according to the first embodiment, the difference between the second connector **20***a* and the second connector is that, in the second connector **20***a*, the guiding portion **25***a* is formed of the second external terminal **23***a* so as to extend along three sides in a continuous manner.

In this manner, as a result of a rounded surface (concave surface) of the second external terminal **23***a*, which is made of a metal, coming into contact with an entire contact surface of the guiding portion **25***a* of the second connector **20** that is brought into contact with the first connector **10**, an acceptable range of positional deviation in which the first connector **10** can be guided is wide, and deformation of the resin members included in the second connector **20** can be suppressed. In other words, as a result of the guiding portion **25***a* being formed to have a continuous surface, an operator does not feel some of the terminals getting caught during a guiding operation, and this results in better sensation of the guiding operation. Accordingly, the possibility of deformation of the terminals occurring when improper fitting is performed can be reduced.

The inclined surface **26***a* of the guiding portion **25***a* is formed of a rolled metal surface. In other words, the inclined surface **26***a* is not formed of either a fracture surface of a metal plate or a tapered portion of such a fracture surface and is formed of a rolled metal surface, and thus, the inclined surface **26***a* can be a smooth surface.

In addition, a cutout portion **28***a* is formed in a lower end portion of the inclined surface **26***a* that is formed at a corner of the guiding portion **25***a*. As a result, the press-workability of the second external terminal **23***a* can be improved.

Note that the present disclosure includes suitable combinations of arbitrary embodiments among the above-described various embodiments, and the advantageous effects of the embodiments can be obtained.

A connector set according to the present embodiment makes it easier to guide a first connector to a correct position when the first connector and a second connector are fitted together, so that deformation of first and second internal terminals can be suppressed, and the probability that the first connector and the second connector may become unable to fit together can be reduced. Accordingly, the present embodiment is useful as a connector set.

What is claimed is:

**1**. A connector set including a first connector and a second connector configured to face each other to fit together,

the first connector including

a first internal terminal that includes terminals along a longitudinal direction,

a first insulating member that supports the first internal terminal, and

first external terminals that are at two ends of the first internal terminal in the longitudinal direction,

the second connector including

a second internal terminal that includes terminals along a longitudinal direction and is configured to engage with the first internal terminal of the first connector,

a second insulating member that supports the second internal terminal, and

second external terminals that are at two ends of the second internal terminal in the longitudinal direction,

wherein

the first connector includes projecting portions that project further toward the second connector than the first internal terminal does in a direction in which the first connector and the second connector are fitted together, and each of the projecting portions of the first connector is provided as a portion of one of the first external terminals, and

the second connector includes recesses, in which the projecting portions of the first connector are accommodated, and guiding portions, each of the guiding portions surrounding a respective one of the recesses.

**2**. The connector set according to claim **1**, wherein

the guiding portions each project further toward the first connector than the second internal terminal does in the direction in which the first connector and the second connector are fitted together.

**3**. The connector set according to claim **1**, wherein

each of the projecting portions of the first connector is made of a metal.

**4**. The connector set according to claim **1**, wherein

each of the guiding portions of the second connector has an inclined surface that is in the vicinity of one of the recesses and that is inclined toward the recess.

**5**. The connector set according to claim **4**, wherein

the inclined surface is continuous surface surrounding the recess.

**6**. The connector set according to claim **4**, wherein

each of the guiding portions of the second connector has a plurality of inclined surfaces, the inclined surfaces are each on three sides surrounding the recess.

**7**. The connector set according to claim **4**, wherein

in the direction in which the first connector and the second connector are fitted together, a difference in height between each of the projecting portions of the first connector and the first internal terminal is equal to or larger than a difference in height between the second internal terminal of the second connector and a lower end portion of the inclined surface of each of the guiding portions.

**8**. The connector set according to claim **1**, wherein

each of the recesses of the second connector is a through hole that extends through the second connector.

**9**. The connector set according to claim **1**, wherein

each of the guiding portions of the second connector is provided as a portion of one of the second external terminals.

**10**. The connector set according to claim **1**, wherein

each of the guiding portions of the second connector is made of a metal.

**11**. The connector set according to claim **1**, wherein

the first connector includes to-be-guided portions, each of the to-be-guided portions being made of a metal, and each of the to-be-guided portions has three surfaces perpendicular to a fitting plane in which the first connector and the second connector are fitted together and a convex surface that connects the three surfaces in a contiguous manner.

**12**. The connector set according to claim **11**, wherein

each of the to-be-guided portions of the first connector is provided as a portion of one of the first external terminals.

**13**. A connector set including a first connector and a second connector configured to face each other to fit together,

the first connector including

a first internal terminal that includes terminals along a longitudinal direction,

a first insulating member that supports the first internal terminal, and

first external terminals that are at two ends of the first internal terminal in the longitudinal direction,

the second connector including

a second internal terminal that includes terminals along a longitudinal direction and is configured to engage with the first internal terminal of the first connector,

a second insulating member that supports the second internal terminal, and

second external terminals that are at two ends of the second internal terminal in the longitudinal direction,

wherein

the first connector includes projecting portions that project further toward the second connector than the first internal terminal does in a direction in which the first connector and the second connector are fitted together, and each of the projecting portions of the first connector is provided as a portion of one of the first external terminals, and

the second connector includes recesses in which the projecting portions of the first connector are accommodated and guiding portions, each of the guiding portions having an inclined surface inclined from the top surface of the second external terminal to a respective one of the recesses.

**14**. The connector set according to claim **13**, wherein

each of the guiding portions surrounds a respective one of the recesses.

**15**. The connector set according to claim **14**, wherein

the inclined surface is continuous surface surrounding the respective one of the recesses.

**16**. The connector set according to claim **14**, wherein

each of the guiding portions of the second connector has a plurality of inclined surfaces, the inclined surfaces being on three sides surrounding the respective one of the recesses.

**17**. The connector set according to claim **13**, wherein

the guiding portions each project further toward the first connector than the second internal terminal does in the direction in which the first connector and the second connector are fitted together.

**18**. The connector set according to claim **13**, wherein

in the direction in which the first connector and the second connector are fitted together, a difference in height between each of the projecting portions of the first connector and the first internal terminal is equal to or larger than a difference in height between the second internal terminal of the second connector and a lower end portion of the inclined surface of each of the guiding portions.

* * * * *